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Chronostratigraphy of an Eroding Complex Atlantic Round House, Baile Sear, Scotland

Tim Kinnaird,^{1,2} Tom Dawson,³ David Sanderson,¹
Derek Hamilton ,¹ Alan Cresswell,¹ and Rebecca Rennell⁴

¹*Scottish Universities Environmental Research Centre, University of Glasgow, East Kilbride, UK*

²*School of Earth and Environmental Sciences, University of St. Andrews, St. Andrews, UK*

³*School of Art History, University of Saint Andrews, Saint Andrews, UK*

⁴*Archaeological Institute, University of the Highlands and Islands – Lewis Castle College, Stornoway, UK*

ABSTRACT

A high-resolution chronostratigraphy has been established for an eroding Atlantic round house at Sloc Sàbhaidh (North Uist, Scotland), combining detailed OSL profiling and dating of sediments encompassing the main bracketing events associated with the monument, radiocarbon AMS dates on bone recovered from excavated features and fills within it, and TL dates on pottery and burnt clay. Concordant OSL and radiocarbon evidence place construction of the wheelhouse in the first to second centuries AD, contemporary with dates from the primary occupation. Beneath the wheelhouse, clay deposits containing burnt material, attest to cultural activity in vicinity to the monument in the preceding second to first centuries BC. At a later date, the southern wall collapsed, was rebuilt, and the interior spaces to the monument re-structured. The chronology for the later horizons identified from the sediment luminescence dates extends to the second half of the first millennium AD, which goes beyond the

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Address correspondence to Tim Charles Kinnaird, School of Earth and Environmental Sciences, University of St. Andrews, St. Andrews KY16 9AL, UK. E-mail: tk17@st-andrews.ac.uk

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range of the radiocarbon dates obtained. The data from ceramics encompass both periods. The juxtaposition of the dating evidence is discussed relative to short and longer chronologies for this Iron Age monument. Corollaries of this research are the implications that based on the long chronology, some of the ecofacts (bone) appear to be residual, and that the temporal duration of Hebridean Coarse Ware may extend into the second half of the first millennium AD.

Keywords chronology, geoarchaeology, household archaeology

INTRODUCTION

This paper documents the chronostratigraphy of an eroding complex Atlantic round house at Sloc Sàbhaidh, situated on the west coast of Baile Sear, a tidal island that lies 0.5 km off the south-west coast of North Uist (Scotland, UK). This monument was exposed during a storm in 2005, necessitating the need for archaeological excavations and intervention. The monument survived as a stone structure with an internal diameter of ca. 12 m and ca. 1.5 m height, with a circular external wall, internally divided by piers/slabs.

The geomorphology of the west coast of Baile Sear is complex, resulting from the continual re-working of sediment stored on the gently sloping continental shelf that extends into the Atlantic (Gilbertson et al. 1996; Hall 1996), coupled with the gradual Holocene rise in sea level since deglaciation. Together, these processes have produced the distinctive machair grassland, a plain of fertile calcareous soils that borders the west coast. This highly dynamic environment is subject to constant erosion and deposition, highlighting the challenges associated with dating island and coastal settlements in this special issue (Krus and Thompson).

BACKGROUND

Settlement on the machair

A number of long-lived prehistoric settlement mounds have been identified, indicating that the fertile machair grasslands have formed a focus for human occupation since the mid third millennium BC

(Parker Pearson et al. 2004:43). To date, the only identified evidence for prehistoric settlements on the Baile Sear machair has been found at Sloc Sàbhaidh and Ceardach Ruadh. The antiquarian, Erskine Beveridge (2001) was the first person to record both Ceardach Ruadh and Sloc Sàbhaidh, noting the presence of midden deposits and a range of artifacts, although he made no mention of structures. Fairhurst and Ritchie (1963) suggested that masonry revealed at Ceardach Ruadh indicated the presence of a wheelhouse, a complex form of an Atlantic roundhouse, in which a radial arrangement of interior stone piers form the basis for lintel arches to support a corbelled roof. In 1983, Barber (2003), documented from an eroding section at Ceardach Ruadh, the presence of a cultivation horizon that produced a radiocarbon date in the Late Bronze Age, overlain by extensive midden deposits and domestic structures dating to the Middle to Late Iron Age. Although the excavation did not clarify the nature of the settlement, the structural remains may represent one or more wheelhouses. Elsewhere, in the Hebrides, similar structures that have been dated tend to fall within the period 25 BC to 380 AD.

Excavation at Sloc Sàbhaidh

The site at Sloc Sàbhaidh remained unexplored until a storm in 2005 eroded the coast edge, revealing two drystone structures. The discovery was reported by local heritage group, Access Archaeology, who teamed up with The SCAPE Trust and the University of St Andrews to record the masonry. Due to the rapid rate of erosion—the coast edge retreated 3 m between

August and December 2005 (Stentoft et al. 2007)—a project to record the two structures commenced in 2006 and continued until 2010 (Dawson 2010; MacDonald and McHardy 2008; Rennell and McHardy 2009; Stentoft et al. 2007).

This manuscript details the excavation and chronology of the better preserved of the two structures. The excavation of the wheelhouse at Sloc Sàbhaidh, Baile Sear, was conducted over four seasons between 2006 and 2010, and revealed a circular dry-stone wheelhouse with an internal diameter of approximately 10 m. The western part of the building (closest to the sea) was suffering active erosion, but much of the structure and associated archaeological deposits were well-preserved, and half of the building was buried within the coastal dune. Excavation focused on elements located on the beach, partly due to concerns from the crofters that disturbance of the dune would lead to increased erosion in the future. This meant that only one half of the structure was excavated, resulting in a large section through the deposits being visible to the east of the excavation.

The excavations revealed a typical wheelhouse with radial piers and central hearth. A 'floor' (comprising micro layers of burned material mixed with sand), covered a number of pits containing animal bone and pottery, thought to be evidence of the primary occupation. At a later date, the southern wall collapsed, resulting in structural modification to the building. The rebuilt wall covered at least one of the wheelhouse piers on the southern side, preventing the structure from functioning as a true wheelhouse. Either at the same time or subsequent to the rebuild, sand was deposited over the central hearth and southern part of the building, placing this half of the structure out of use. The sand was not horizontally bedded, and numerous tip marks were evident. Occupation continued in the northern half of the building, and a series of superimposed hearths and associated deposits were excavated. One of these hearths, located in the central space, was decorated by two intersecting sets of lines in the form of a cross. Evidence of the final

abandonment of the structure is provided by layers of clean aeolian sand.

OSL PROFILING AND DATING OF SEDIMENT

The site was visited by David Sanderson in September 2010 to collect samples for optically stimulated luminescence (OSL) profiling and dating. The sediments exposed in the section, associated with the monument and its immediate environment, were reviewed and luminescence profiling was undertaken to evaluate the archaeological sequences (Figures 1 and 2; see also Kinnaird et al. 2015, 2017; Sanderson and Murphy 2010), and to identify sampling positions for OSL dating (see supplementary data S1). At the time of this visit, the floor layers had been revealed, but excavation had not yet started, restricting access to early occupational layers for sampling. The sequence of pre-existing deposits, construction of the southern and northern walls, the southern wall collapse and associated rebuild, abandonment of the southern areas, the occupation sequence of the northern areas and its subsequent abandonment, were covered by seven profiles, comprising 58 profiling samples and 11 tube samples.

Profiles 1 and 2 examined substrates below the wheelhouse structure, and an underlying burnt earth surface which may be associated with earlier cultural activity in vicinity of the wheelhouse. The dating questions associated with these materials relate to the age of the formation of the burnt surface as well as providing a terminus post quem (TPQ) for the construction of the wheelhouse walls. Profiles 3 and 4 examined the stratigraphy of sediments immediately outside the southern wall of the wheelhouse, which may be associated with the original wall construction, a collapse of the southern wall, and its subsequent rebuilding. The dating questions here relate to the timing of the original construction and/or collapse (evidence provided by a cut feature seen in section against the southern wall) and rebuilding events relative to the occupation evidence within the southern

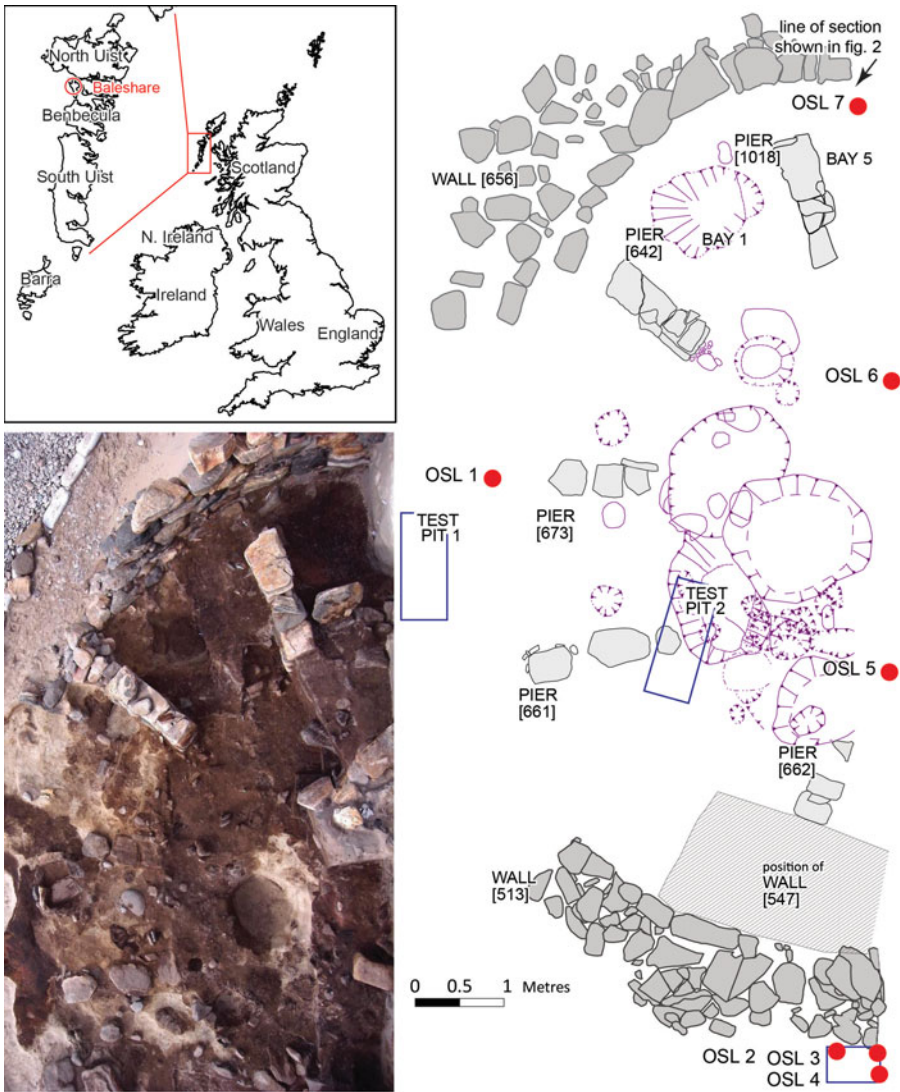


Figure 1. a) Location of Baile Sear (Baleshare), North Uist; b) aerial view of northern part of site, showing upstanding piers [642] and [1018]. Floor deposits not fully excavated; c) plan of wheelhouse, showing spatial distribution of OSL samples. Images b) and c) copyright SCAPE.

chamber. Profile 5 examined the backfilled materials in the southern chamber, leading to the deliberate abandonment of this part of the wheelhouse. The chronology of this abandonment relative to the wall rebuild is of interest. Profiles 6 and 7 examined the infill of the central north and northern interior areas, including occupational evi-

dence, a later sequence of hearths (which appeared to be constructed after the back-filling event), and aeolian sands deposited after the final abandonment.

The results from field profiling were informative, with the substrate, archaeological materials, clean aeolian sands (post-dating abandonment) and modern sands,

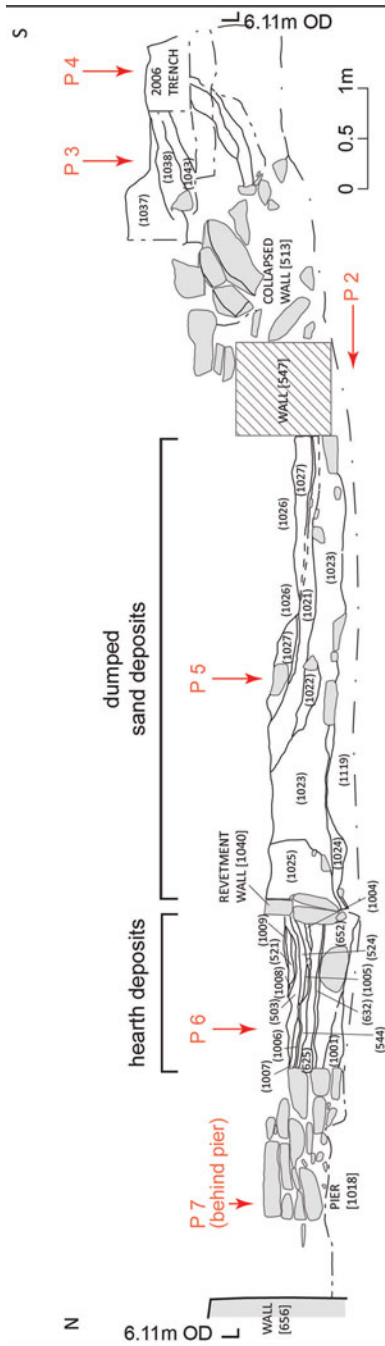


Figure 2. East facing section illustrating deposits within the wheelhouse, with hearth deposits between pier [1018] and revetment wall [1040] (Figure 3) and dumped sand layers to the south (Figure 4). Profile 1 is positioned at OSL1 on Figure 1. Copyright SCAPE.

all showing promising contrasts in luminescence intensities and depletion ratios (Figure 3; Table S1.1). Moreover, as these initial measurements were undertaken on site and undertaken in near real-time, dating priorities were coupled directly with archaeological objectives, and relative temporal frameworks were constructed for the sedimentary stratigraphies (Figures 3 and 4). The investigated substrate stratigraphies to the monument, including the sands which cover the burnt surface, all represent relatively short temporal sequences. The dynamic ranges in OSL and IRSL net signal intensities for the sands directly beneath the structure (TPQ for construction) and for the ‘floor’ layers within it, are not suggestive of a substantial temporal break (tabulated in S1). In contrast, the dynamic range in intensities between the substrate layers and sediments associated with the re-packing of the southern wall after collapse are suggestive of a temporal break (Figure 3).

With the relative temporal framework established, which agreed with the recorded archaeological stratigraphic sequence, the investigations progressed to more formal laboratory analysis, first to exploratory luminescence screening and characterization, then to more conventional quantitative quartz OSL dating. Sample preparation and analysis was undertaken at the Scottish Universities Environmental Research Centre (SUERC). For each profiling position, paired analyses were undertaken on quartz and polymineral extracts, using a simplified two-step single aliquot regenerative dose (SAR) OSL protocol (Table S2.1). The data were used to plot depth-dose and depth-sensitivity profiles for each section (Figures 3 and 4). These analyses largely corroborated the hypotheses raised during field profiling—strengthening the argument for a prolonged (and potentially multi-period) occupation of the wheelhouse, but also confirmed that most OSL samples had failed to capture the primary occupational layers.

OSL SAR dating utilizes extracted quartz from the samples to determine the radiation dose experienced by the sediments since their last zeroing event,

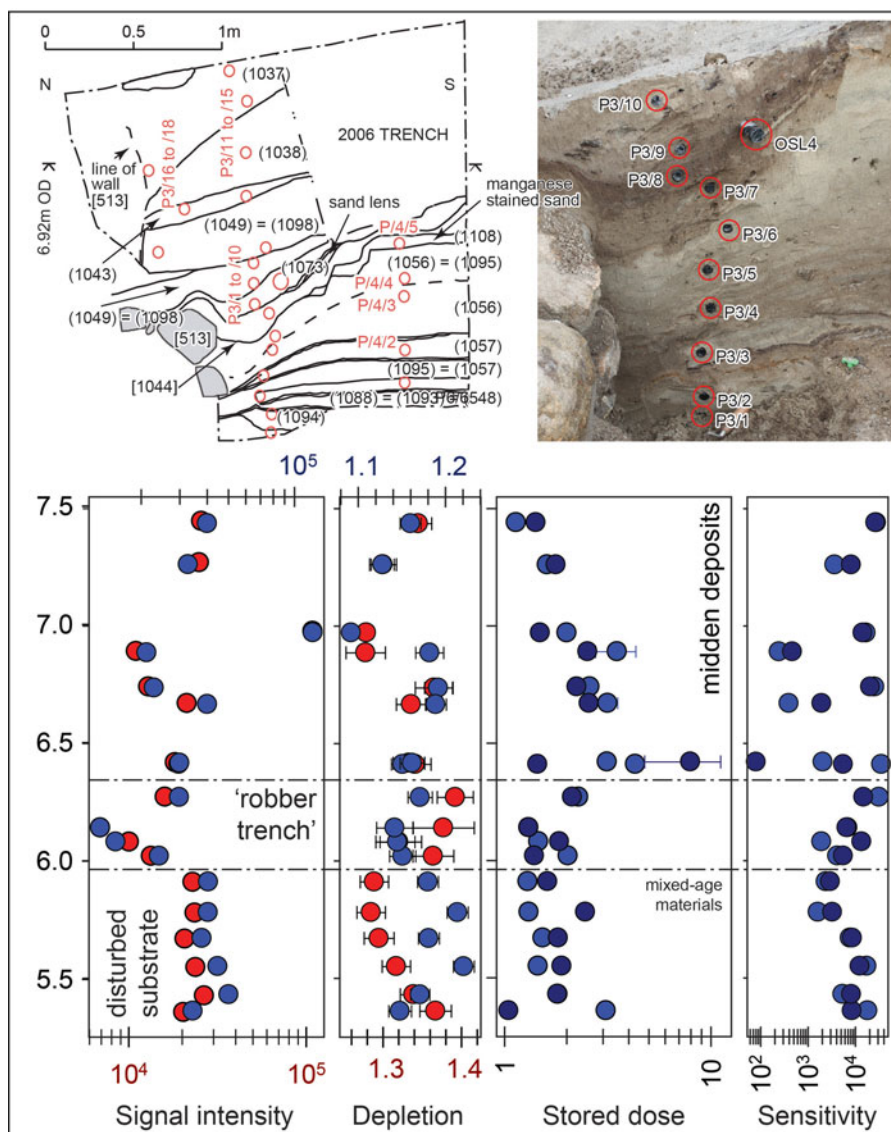


Figure 3. Sequence of deposits south of the wheelhouse; a) east facing section; b) photograph of lower sequence, with profiling positions marked; c) field- and laboratory- luminescence profiles, annotated relative to stratigraphy, with main observations noted. Key to symbols (here, and for Figure 4): Red circles, net IRSL signal intensities and depletion indices (in red), Blue circles, net OSL signal intensities and depletion indices (in blue).

assumed to be by exposure to light prior to final deposition. This is combined with dose rate analysis based on field and laboratory measurements of environmental

radioactivity. The age is determined as the ratio of dose divided by dose rate. In this work, dose rates for the bulk sediment were quantified using high resolution

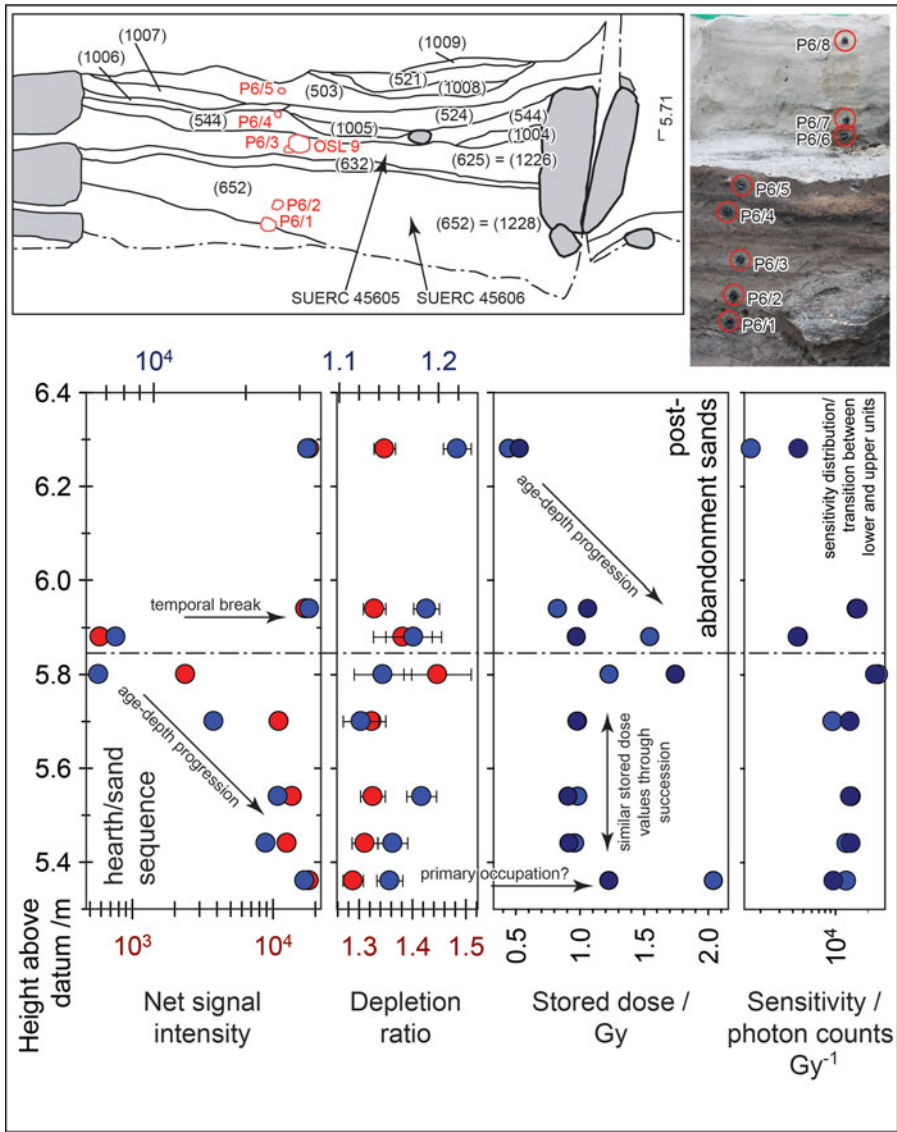


Figure 4. Hearth deposits between pier [1018] and revetment wall [1040]; a) east facing section; b) photograph of sequence, with profiling positions marked; c) field- and laboratory-luminescence profiles, annotated relative to stratigraphy, with main observations noted.

gamma spectrometry (HRGS) and thick source beta counting (TSBC) in the laboratory, coupled with water content analysis and in situ gamma dose rate measurements (Tables S3.1–3.3). Quartz was extracted using standard laboratory

procedures, and purity checked with scanning electron microscopy (SEM). Equivalent doses were determined, initially, on 16 aliquots of quartz per sample using the quartz OSL SAR procedure, with additional investigation of further sets of 16 to build

Table 1. Quartz SAR OSL ages for sediments associated with the monument and the immediate environment.

SUTL No.	Field No.	Profile	Dose Rate/ mGy a ⁻¹	Stored Dose/Gy	Years BP	Calendar years
2392	OSL1	1	1.08 ± 0.09	2.54 ± 0.13	2350 ± 230	340 ± 230 BC
2393	OSL2	2	1.21 ± 0.09	2.24 ± 0.10	1855 ± 160	AD 160 ± 160
2394	OSL3	2	1.29 ± 0.06	2.45 ± 0.20	1895 ± 180	AD 110 ± 180
2395	OSL4	3	1.24 ± 0.06	1.55 ± 0.02	1245 ± 60	AD 765 ± 60
2397	OSL6	5	1.02 ± 0.06	1.47 ± 0.02	1240 ± 75	AD 770 ± 75
2398	OSL7	5	1.17 ± 0.06	1.51 ± 0.05	1290 ± 75	AD 720 ± 75
2399	OSL8	6	1.10 ± 0.06	1.44 ± 0.07	1313 ± 95	AD 695 ± 95
2400	OSL9	6	1.10 ± 0.06	1.18 ± 0.03	1070 ± 70	AD 940 ± 70
2401	OSL10	6	1.03 ± 0.06	1.12 ± 0.03	1085 ± 70	AD 925 ± 70
2402	OSL11	7	1.10 ± 0.08	2.05 ± 0.22	1875 ± 250	AD 135 ± 250

statistical power for selected pre-heating groups (Tables S4.1–4.2). Radial plotting methods were used to appraise sample homogeneity, and robust statistics were used, for aliquots satisfying SAR acceptance criteria to estimate equivalent doses for age determinations.

The individual sediment ages fall into three groups (Table 1): an earlier set in the first to second century AD, for the sands beneath the wheelhouse (TPQ for construction; SUTL2393–94, 2402); a later set in the sixth to seventh century AD, for the sands immediately outside the southern wall, leading to the interpretation that they are associated with a collapse of the southern wall and its subsequent re-build; and the backfilled materials in the southern chamber (dating the re-modelling of the internal space; SUTL2395, 2397–98); and finally, a set in the ninth to tenth centuries AD, for the last hearth to be fired in the northern chamber (SUTL2400), and for the post-abandonment sands (*terminus ante quem* (TAQ) for abandonment; SUTL2401). It was possible to augment (and extend) the sediment chronologies, by returning to the apparent doses obtained from the exploratory laboratory analyses, and calculating an apparent age using the dose rate estimates from the adjacent dating positions.

Moreover, the combination of the quartz OSL SAR ages and profiling dating,

assessed relative to the stratigraphy of the wheelhouse, allows for both conventional statistical assimilation and Bayesian methods. Bayesian models have been used in radiocarbon dating for several years (e.g., Buck et al. 1996) to evaluate dates in sequences that are constrained stratigraphically, interpret these dates in terms of archaeological events, and to reduce age estimate uncertainties (see data S5). The model parameters are presented as a matrix in Figure S5.1. TPQ for construction is provided by the 4 quartz SAR ages from beneath the structure (SUTL2392–94, 2401; Figure S5.1). The stratigraphic relationship between the sands sampled beneath the northern wall and the burnt surface is not known. A single sample constrains the timing of the cut feature observed in section outside the southern wall, which has been interpreted through this dating model as relating to the collapse and subsequent re-build of this wall (SUTL2395). This event is further constrained by two samples from within the southern interior space, from sediments deliberately back-filled, related to first modification, then abandonment of this space (SUTL2397–98). The southern wall needs to have been in place before this space was backfilled, as the sediments abut this wall. The northern interior space remained in use after the southern chamber was abandoned and two

samples constrain the period of occupation of the central chamber (SUTL2399-2400). A single sample from clean aeolian sands post-dates abandonment (SUTL2401) and provides TAQ for abandonment of the wheelhouse.

Two Bayesian models were investigated: model A was populated with the quartz OSL SAR ages (Figure S5.2; $A_{\text{model}} = 86$; $A_{\text{overall}} = 94$); model B was additionally populated with age estimates obtained from laboratory profiling (Figure 5 or S5.3; $A_{\text{model}} = 74$). Under Model B, the most probable duration for accumulation of the burnt surface underneath the wheelhouse construction is *240 BC to 80 AD (95% probability)* and most probably in *160 BC to 5 BC (68% probability)*; Figure S5.4). Taking account of the model B constraints for the samples immediately underneath the wheelhouse southern and northern walls, in combination with the constraints imposed by the underlying burnt surface, we infer a most probable date for construction of the wheelhouse between *140 BC to 240 AD (95% probability)* and most probably between *60 BC to 140 AD (68% probability)*. The period in which the southern wall collapsed, was re-built, and by inference the southern chamber abandoned, with deliberate backfilling, is dated to *330 to 790 (95% probability)* and most probably, *475 to 740 AD (68% probability)*. The wheelhouse had been abandoned by *825 to 995 AD (95% probability)*, and most probably by *870 to 950 AD (68% probability)*.

RADIOCARBON DATING

The archaeological excavations were completed by October 2010. In post-excavation, 12 fragments of bone collected from contexts attributed to primary occupation (four samples; floor layers, and from pits sealed by these), the hearth sequence in the central north chamber (two samples), the disturbed sediments outside the southern wall (three samples), and the packed materials in the southern chamber (two samples) were submitted to the SUERC radiocarbon facilities for AMS dating (Table 2).

The 'floor' layers within the wheelhouse provide the evidence for the primary occupation. These layers, located across the entire internal area (apart from the western edge, which was truncated by erosion), consisted of numerous micro layers of sand mixed with burnt material. It was not possible to follow any one particular 'floor', so the deposits were excavated in 50 mm deep spits by 1 m grid squares. The calibrated radiocarbon dates of bone recovered from the floor layers at 58 to 217 cal AD and 121 to 254 cal AD (*at 95%, Table 2*), and from pits sealed by these horizons, at 129 to 258 cal AD and 137 to 345 cal AD (*at 95%, Table 2*), constrain primary occupation to the second to third centuries AD.

In the central northern chamber, radiocarbon dates were obtained from bone from the layers of peat ash deposited around the series of superimposed hearths that were in use after the abandonment of the southern part of the building. At 241 to 390 cal AD and 242 to 391 cal AD (*at 95%, Table 2*), these document occupation in the third to fourth centuries AD. The radiocarbon samples are from contexts above and beneath the OSL samples (SUTL2399 & 2400).

The radiocarbon constraints on the restructuring of southern part of the wheelhouse, are obtained in part from the fill of the construction trench/robber cut, and in part, the backfill of the southern chamber. The radiocarbon dates obtained for bones enclosed within the fill of the cut feature outside the southern wall at 753 to 412 cal BC, 795 to 541 cal BC and 85 to 239 cal AD (*at 95%, Table 2*), are not thought to date the cut, rather to represent residual materials, most probably derived from the midden deposits which abut the southern wall. However, they do provide a TPQ for this event. In the southern chamber, the bones from within the dumped materials dated at 215 to 387 cal AD and 254 to 400 cal AD (*at 95%, Table 2*), would suggest, if these materials were also not residual, that the southern interior space was abandoned by the fourth century AD.

Therefore, purely on the radiocarbon evidence, the site history of the Baile Sear wheelhouse could be interpreted in terms of a *shorter* chronology, spanning from

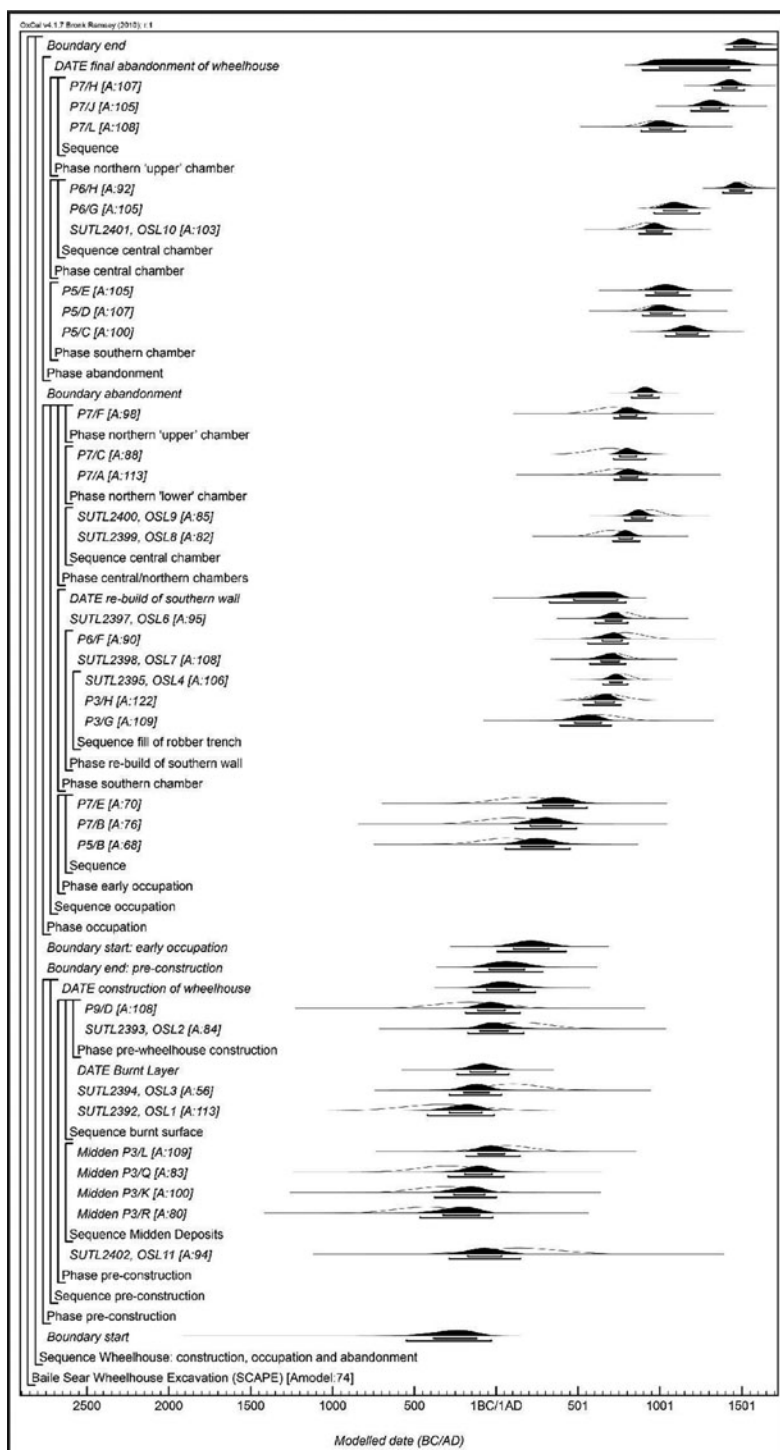


Figure 5. Bayesian age model B.

Table 2. AMS dates from bone recovered from the Baile Sear wheelhouse.

Lab ref	Context	Age BP	$\delta^{13}\text{C}$ relative to		$\delta^{15}\text{N}$ relative to Air	C/N ratio (molar)	Equivalent to	Calibrated radiocarbon date	
			VPDB					at 1 sigma (68.2%)	at 2 sigma (95.4%)
SUERC-45596	1039	1753 ± 29	- 21.1		4.3	3.4	>P5/5 & OSL6	274 to 334 cal AD (48.9%) to 265 cal AD (19.3%)	241 215 to 387 cal AD (95.4%)
SUERC-45597	1053	1712 ± 27	- 21.5		4.7	3.3	=P5/4, <OSL6	323 to 384 cal AD (48.7%) to 284 cal AD (19.5%)	260 254 to 400 cal AD (95.4%)
SUERC-45594	1038	1844 ± 29	- 21.2		4.5	3.3	=P3/13	130 to 215 cal AD (68.2%)	85 to 239 cal AD (95.4%)
SUERC-45595	1049	2454 ± 25	- 20.6		4.9	3.3	=P3/9, >OSL4	747 to 688 cal BC (25.7%) to 503 cal BC (20.5%)	554 597 to 412 cal BC (54.5%)
								665 to 645 cal BC (8.0%)	753 to 688 cal BC (27.5%)
								441 to 418 cal BC (7.1%)	667 to 632 cal BC (11.2%)
								462 to 450 cal BC (3.4%)	
SUERC-45598	1056	2526 ± 29	- 21.2		6.1	3.3	P3/4-6	642 to 592 cal BC (27.3%) to 749 cal BC (22.5%)	785 694 to 541 cal BC (68.8%)
								688 to 666 cal BC (14.7%)	795 to 727 (29.9%)
								577 to 569 cal BC (3.7%)	
SUERC-45605	1226	1729 ± 29	- 21.5		4.4	3.3	=P6/3, <OSL9	255 to 306 cal AD (40.5%) to 346 cal AD (25.6%)	312 241 to 390 cal AD (95.4%)
SUERC-45606	1228	1728 ± 29	- 21.4		5.0	3.3	=P6/2 & OSL8	255 to 305 cal AD (38.6%) to 327 cal AD (25.4%)	312 242 to 391 cal AD (95.4%)
								370 to 377 cal AD (4.2%)	
SUERC-45599	1119	1889 ± 29	- 21.1		5.2	3.3	PO	68 to 135 cal AD (68.2%)	58 to 217 cal AD (95.8%)
SUERC-45603	1123	1827 ± 29	- 21.1		5.1	3.3	PO	137 to 225 cal AD (68.2%)	121 to 254 cal AD (92.7%)
									87 to 104 cal AD (2.3%)
SUERC-45593	1210	1808 ± 27	- 21.1		5.0	3.2	PO	208 to 242 cal AD (31.0%) to 196 cal AD (23.1%)	166 129 to 258 cal AD (90.8%)
								139 to 159 cal AD (14.1%)	299 to 319 cal (4.6%)
SUERC-45589	1017	1770 ± 29	- 21.2		4.8	3.2	P7/1-/-3	228 to 263 cal AD (29.5%) to 329 cal AD (38.7%)	278 137 to 345 cal AD (95.4%)

Abbreviations as follows: > above, < below; PO = Primary occupation.

the first to second centuries AD to the fourth century AD, with re-structuring of the southern interior space by the second to third century AD, its abandonment, and then restricted occupation in the central north and northern areas into the fourth century AD.

TL DATING OF HEATED MATERIALS

The sediment samples and chronology do not directly register the primary occupation, which appears as a temporal gap in the Bayesian sequences of both the OSL dating samples and the generalized chronology from the profiling samples (these archaeological layers were unexcavated at the time of OSL sampling). The evidence for primary occupation includes radiocarbon dating samples from primary contexts and Hebridean Coarse Ware, traditionally attributed to the first half of the first millennium AD. Some of this material however appeared to come from parts of the site which post-date the step in sediment chronologies (Figure 5; although these layers also produced radiocarbon dates indicative of a *shorter* temporal sequence).

Here, luminescence methods are applied, to determine the period of last heating of fragments of a ceramic hearth associated with the lower part of the 'hearth sequence' in the central chamber, and a series of pottery sherds taken from adjacent units. Initially, 8 sub-samples of fragmentary material from the clay hearth, and 14 pottery sherds were examined (of which 11 were taken through dating proce-

dures). In this study, the sherd size limited the yields of quartz available from interior portions, and also the quantity of material available for dose rate determinations to less than the 20 g de-minimus sample size which is normally used for beta and gamma analysis at SUERC. Accordingly, procedures were adapted to permit 10 g radionuclide analyses where needed. Quartz SAR investigations from the sherds were limited to a single pre-heating temperature, based on the preheating data obtained from the sediments from this site. The quartz OSL results from both the hearth material and the sherds produced unsatisfactory results, with apparent ages from the last 500 to 1,000 years and failures of dose recovery tests in the laboratory under the pre-heating regime used for the ceramics. Accordingly, the feldspar extracts were also investigated using a series of different stimulation and quantification approaches. Multi-stimulation single aliquot regenerative-additive (SARA) methods were used with prolonged 16 hr preheating at 120 °C on the natural cycle to stabilize fading (see supplementary data S6). Within the available precision, the majority of these data support the long chronology of the sediment sequence and imply that coarse ware comes from the later first millennium AD.

Subsequently, the investigations were extended, to include five sherds recovered from pits in the wheelhouse floor in areas adjacent to the lower sedimentary sequences in the central and northern chambers. Further studies were also undertaken using quartz extracts from the ceramic hearth to assess the potential of using

Table 3. Feldspar TL SARA results: Total dose rates, stored dose and age estimates.

SUTL No.	from context	Pottery ID	Dose rate/ mGy a ⁻¹	Stored dose/Gy	Years BP	Calendar years
2787	1017	P685	2.08 ± 0.1	2.89 ± 0.49	1.4 ± 0.3	AD 620 ± 250
2788		P713	2.11 ± 0.1	2.75 ± 0.17	1.3 ± 0.1	AD 720 ± 100
2789		P716	2.12 ± 0.1	2.76 ± 0.32	1.3 ± 0.2	AD 710 ± 160
2790	1123	P1636	2.46 ± 0.1	3.14 ± 0.31	1.3 ± 0.1	AD 740 ± 140
2791	1167	P1218	2.49 ± 0.1	3.59 ± 0.11	1.4 ± 0.1	AD 580 ± 70

Table 4. Quartz OSL SAR results: Total dose rates, stored dose and age estimates.

SUTL No.	From context	Pottery ID	Dose rate/ mGy a ⁻¹	Stored/ Gy	Years BP	Calendar years
2787	1017	P685	2.01 ± 0.10	2.79 ± 0.07	1.4 ± 0.1	AD 630 ± 80
2788		P713	2.05 ± 0.10	2.70 ± 0.10	1.3 ± 0.1	AD 700 ± 80
2789		P716	2.06 ± 0.09	2.60 ± 0.05	1.3 ± 0.1	AD 750 ± 60
2790	1123	P1636	2.40 ± 0.11	2.82 ± 0.04	1.2 ± 0.1	AD 840 ± 60
2791	1167	P1218	2.43 ± 0.09	3.26 ± 0.05	1.3 ± 0.1	AD 680 ± 50
2651	clay hearth	—	2.12 ± 0.12	3.53 ± 0.04	1.7 ± 0.1	AD 350 ± 90
2653		—	2.12 ± 0.12	3.16 ± 0.05	1.5 ± 0.1	AD 520 ± 90
2654		—	2.04 ± 0.15	3.64 ± 0.05	1.8 ± 0.1	AD 230 ± 140

more aggressive pre-heating to resolve the unsatisfactory quartz behavior observed in 2014. With higher pre-heating temperatures of 250–280 °C satisfactory dose recovery behavior was observed in this material, and also in the later sherds. For these materials, both quartz OSL SAR and feldspar SARA analyses were undertaken, and yielded luminescence dates (Tables 3 and 4). For the hearth, the individual ages (after refinement of the dating protocol), fall within the period AD 350 ± 100 (SUTL2651), AD 520 ± 90 (SUTL2653) and AD 230 ± 140 (SUTL2654), with statistical combinations suggesting a date of AD 410 ± 60. It must be noted that these dates are from undecorated fragments of the hearth; as such, we can only indirectly relate these to the decorated central portion of the hearth, with the assumption that they were well-fired and the luminescence signals reset. The dates fall within the period between construction and early occupation, and later occupation associated with the modification of the internal space of the wheelhouse. Broadly concordant quartz and K feldspar luminescence ages were obtained for the pottery sherds, with individual quartz OSL SAR ages in the range sixth to seventh centuries AD, and K feldspar post-IR TL SARA ages in the range fifth to seventh centuries AD.

DISCUSSIONS AND CONCLUSIONS

All chronological evidence has been assessed relative to the stratigraphy of the

wheelhouse and its immediate environment using conventional assimilation and Bayesian statistical methods, in combination with our archaeological observations, and the field- and laboratory-luminescence profiling data.

For the early site history, the OSL and radiocarbon chronologies are concordant, with construction of the wheelhouse in the first to second century AD, contemporaneous with the primary occupation. Moreover, both provide evidence of earlier cultural activity in vicinity to the monument. Beneath the wheelhouse, clay deposits containing burnt material, attest to cultural activity nearby in the second to first century BC. Midden deposits which abut the exterior walls of the wheelhouse contain materials dated from the early Iron Age onwards, and it is known that other structures, possibly of earlier date, lie adjacent to the wheelhouse.

Thereafter, the chronological evidence for the later site history is more ambiguous, with the radiocarbon evidence suggesting a *shorter* chronology, and the OSL sediment chronologies and TL dates on pottery, a *longer* chronology.

The short chronology. The site history of the wheelhouse spans from its construction in the first to second centuries AD to abandonment after the fourth century AD. In this temporal framework, the collapse of the southern wall, its rebuild, and then subsequent abandonment of the southern interior space all occurred in the second to third century AD, with occupation

limited to the central north and northern areas thereafter.

The long chronology. In this temporal framework, the collapse of the southern wall, its re-build, and the subsequent modification of the southern interior space, including its deliberate backfilling and abandonment, all occurred in the later part of the first millennium AD, significantly after the wheelhouse construction and earlier phases of occupation. After abandonment of the southern areas, the central north and northern areas remained in use, with occupation through the seventh to the ninth century AD. The wheelhouse must have been abandoned shortly after, as registered by the first occurrence of clean, aeolian sands starting from the ninth century AD. Later evidence of aeolian activity through the Little Ice Age (up to sixteenth century AD) is also recorded in post-abandonment sands.

Apparent ages from OSL profiling augment this temporal framework, suggesting that the northern chamber was in use during all period of occupation, from the Iron Age construction of the wheelhouse (ca. AD 150) through to its abandonment. Evidence for the earliest occupation phase in the southern chamber, is only registered by a single profiling sample from the 'floor' layers (first to second century AD; profile 5).

Implications of the *longer* chronology, are that some of the artifacts appear to have been subject to post-depositional movements. This is true of both the bone and pottery, dated here; although, the bone must be residual. Notwithstanding this, the temporal duration of Hebridean Coarse Ware must extend well into the second half of the first millennium AD. The observations in respect of ceramic traditions, coupled with the diversity of minerals observed by electron microscopy, suggests that further work is needed to examine the duration of ceramics on other sites in the Hebrides.

Whilst a detailed chronostratigraphy has been established for the construction and early occupational sequences of the wheelhouse at Sloc Sàbhaidh, questions still

remain as to the age and duration of the later occupational sequences in the central north and northern areas, and the restructuring of the interior space. The dating project has created two sequences, raising a number of questions that are still being discussed and showing that the dating of what was thought to be a well-understood monument type can be problematic in sand dune environments.

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ORCID

Derek Hamilton  <http://orcid.org/0000-0003-4019-3823>

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